PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference HMJ03181WO	**FOR FURTHER ACTION** see Notification of Transmittal of Int rnational Search R port (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 00/ 03713	International filing date *(day/month/year)* 13/04/2000	(Earliest) Priority Date *(day/month/year)* 13/04/1999
Applicant RASMUSSEN, Ole-Bendt		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

      [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

      [ ] contained in the international application in written form.
      [ ] filed together with the international application in computer readable form.
      [ ] furnished subsequently to this Authority in written form.
      [ ] furnished subsequently to this Authority in computer readble form.
      [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
      [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has be n furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).
3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

   [X] the text is approved as submitted by the applicant.
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [X] the text is approved as submitted by the applicant.
   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of th **drawing** to be published with the abstract is Figure No. 5

   [ ] as suggested by the applicant.
   [X] because the applicant failed to suggest a figure.
   [ ] because this figure better charact riz s th invention.

   [ ] None of the figur s.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/03713

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A23P1/12 A23G3/26 A23G3/20 A23G9/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A23P A23G A23J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 077 072 A (NATIONAL DAIRY PRODUCTS CO.) 24 July 1967 (1967-07-24) figure 1 ---	1,41
X	EP 0 853 888 A (NESTLE SA) 22 July 1998 (1998-07-22) page 2, line 11 - line 49 page 3, line 21 - line 42 ---	99
A	US 3 511 742 A (RASMUSSEN OLE-BENDT) 12 May 1970 (1970-05-12) cited in the application the whole document --- -/--	1,41,44, 65,102, 103

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2000	19/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Vuillamy, V

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 828 780 A (LUKER KEITH W) 9 May 1989 (1989-05-09) cited in the application column 2, line 20 -column 3, line 48 column 9, line 43 - line 58 ---	1,41,44, 65,102, 103
A	US 2 313 060 A (A.FRIEDMAN) 9 March 1943 (1943-03-09) cited in the application the whole document ---	1,41
A	US 5 209 156 A (LOMBARD MARCO H) 11 May 1993 (1993-05-11) column 2, line 50 -column 3, line 49 figures ---	1,41,44, 65,102, 103
A	WO 94 27801 A (KELLOG CO) 8 December 1994 (1994-12-08) figure 1 page 2, line 35 -page 4, line 13 ---	1,41,44, 65,102, 103
P,A	WO 99 34695 A (SCHLEBUSCH JOHANNES P ;EFFEM GMBH (DE); HEMUS JOHN (DE); RONKEN AN) 15 July 1999 (1999-07-15) cited in the application the whole document -----	1,41,44, 65,102, 103

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/03713

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1077072 A		NONE	
EP 0853888 A	22-07-1998	NONE	
US 3511742 A	12-05-1970	AT 336759 B	25-05-1977
		AT 82871 A	15-09-1976
		AT 319457 B	27-12-1974
		AT 299553 B	15-05-1972
		CH 568142 A	31-10-1975
		DE 1569335 A	16-12-1971
		DE 1779929 A	13-01-1972
		DE 1785567 A	05-01-1972
		FI 46926 B	02-05-1973
		FI 45631 B	02-05-1972
		GB 1103114 A	
		IL 21972 A	26-09-1968
		NL 6410073 A,B	01-03-1965
		SE 334462 B	26-04-1971
		SE 364531 B	25-02-1974
US 4828780 A	09-05-1989	NONE	
US 2313060 A	09-03-1943	NONE	
US 5209156 A	11-05-1993	US 5320793 A	14-06-1994
WO 9427801 A	08-12-1994	AU 7045894 A	20-12-1994
WO 9934695 A	15-07-1999	DE 19800390 C	05-08-1999
		AU 2409199 A	26-07-1999

PATENT COOPERATION TRATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 23 October 2000 (23.10.00)	
International application No. PCT/EP00/03713	**Applicant's or agent's file reference** HMJ03181WO
International filing date (day/month/year) 13 April 2000 (13.04.00)	**Priority date** (day/month/year) 13 April 1999 (13.04.99)
Applicant RASMUSSEN, Ole-Bendt	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

27 September 2000 (27.09.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was
[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No.: (41-22) 740.14.35	Authorized officer Claudio Borton Telephone No.: (41-22) 338.83.38

WO 00/60959
PCT/EP00/037

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:
GILL JENNINGS & EVERY
Broadgate House
7 Eldon Street
London EC2M 7LH
ROYAUME-UNI

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

DIARIED

Date of mailing (day/month/year) 19 October 2000 (19.10.00)	
Applicant's or agent's file reference HMJ03181WO	**IMPORTANT NOTICE**

International application No.	International filing date (day/month/year)	Priority date (day/month/year)
PCT/EP00/03713	13 April 2000 (13.04.00)	13 April 1999 (13.04.99)

Applicant
RASMUSSEN, Ole-Bendt

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AG,AU,DZ,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD, GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX, NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   19 October 2000 (19.10.00) under No. WO 00/60959

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

Continuation of F rm PCT/IB/308

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

Date of mailing (day/month/year) 19 October 2000 (19.10.00)	IMPORTANT NOTICE
Applicant's or agent's file reference HMJ03181WO	International application No. PCT/EP00/03713

The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.

REC'D 23 JUL 2001
WIPO PCT

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference HMJ03181WO	**FOR FURTHER ACTION** See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/03713	International filing date *(day/month/year)* 13/04/2000	Priority date *(day/month/year)* 13/04/1999
International Patent Classification (IPC) or national classification and IPC A23P1/12		
Applicant RASMUSSEN, Ole-Bendt		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 31 sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report
   II ☐ Priority
   III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   IV ☐ Lack of unity of invention
   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   VI ☐ Certain documents cited
   VII ☒ Certain defects in the international application
   VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
27/09/2000	19.07.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Van Woensel, G Telephone No. +49 89 2399 2089

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/03713

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)):*

Description, pages:

2,6,18,20,23-26, 31,35,38,39,41	as originally filed			
1,3-5,7-17,19,21, 22,27-30,32-34,36, 37,40,42-44	as received on	21/06/2001	with letter of	19/06/2001

Claims, No.:

1-103	as received on	21/06/2001	with letter of	19/06/2001

Drawings, sheets:

1/16-16/16	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:
   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

   ☐ the entire international application.

   ☒ claims Nos. 41-103.

because:

   ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

   ☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 41-103 are so unclear that no meaningful opinion could be formed (*specify*):
   see separate sheet

   ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

   ☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

   ☐ the written form has not been furnished or does not comply with the standard.
   ☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reason d statement und r Article 35(2) with regard to novelty, inventive step or industrial applicability;

citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-40
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-40
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-40
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Ad III

1. The question of whether the claimed invention appears to be novel, or involve an inventive step or to be industrially applicable has not been the subject of the international preliminary examination (Article 34(4)(a)(i-ii) and 35(3)(a) PCT) because there are unnecessary independent claims (Article 6 PCT, conciseness). The plurality of independent claims makes it impossible to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.
   Therefore, only independent claim 1 (and its dependent claims) has been the subject of the international preliminary examination in view of Article 33(2-4) PCT.

Ad V

1. The subject-matter of claim 1 is novel (Article 33(2) PCT) in view of document EP853888 A, the closest prior art document. Claim 1 also involves an inventive step in view of the prior art cited in the international search report (Article 33(3) PCT). Claims 2-40 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Ad VII

1. Claims 102 and 103 contain reference to the description or the drawings. According to Rule 6.2(a) PCT, claims should not contain such references, except where absolutely necessary, which is not the case here.

Ad VIII

1. Claims 1, 18, 41, 42, 44, etc. contain text between brackets, which text renders the present claims unclear (Article 6 PCT): it is unclear whether said text relates to optional features or to essential features limiting the scope of the invention.

Not entered

FOOD PRODUCT WHICH ARTIFICIALLY HAS BEEN GIVEN A CELL-LIKE STRUCTURE BY COEXTRUSION OF SEVERAL COMPONENTS, AND METHOD AND APPARATUS FOR MANUFACTURING SUCH FOOD PRODUCT

The invention concerns a food product in sheet, ribbon or filament form consisting of at least two components which have been coextruded to become interspersed with each other and form a row-structure, and methods and apparatus for making such product.

In the term "food" product, I intend to include animal food, confectionary and medical products. The inventor's two (expired) patents US-A-4,115,502 and US-A-4,436,568 disclose such products. The former discloses:

a) strands of a viscous sugar solution, interspersed with strands of dough; the coextruded sheet formed product is subsequently baked - and

b) strands of highly viscous, dissolved or swollen protein and a viscous sugar solution, caramel and/or dough; the coextruded sheet formed product is subsequently solidified. (see col. 6 line 65 to col. 7 line 5 of this patent).

The other above mentioned patent contains an operative example for making a similar food product namely example 4. Here an alkaline solution of soya protein is interspersedly, side-by-side coextruded with a solution of carboxy-methyl-cellulose to which is added caramel (for sweetening and aroma). To achieve a regular structure the two solutions have the same viscosity.

The coextruded sheet formed product is collected on a conveyor film of polyester (later to be used as wrap for the product) and is solidified by rinsing a solution of NaCl - lactic acid over it. This causes the protein to coagulate.

In each of the above mentioned examples each of the interspersed strands is a continuous strand. In US-A-4,436,568 this clearly appears from the text of the example when the letter is studied in conjunction with the drawing to which it refers. In US-A-4,115,502 the only apparatus/method which is

Dessert (e.g. crème caramel).....about 3 g cm^{-2}

Marzipan:....about 400 g cm^{-2}

Hardboiled egg white:...about 900 g cm^{-2}

Emmental cheese:.. about 3 kg cm^{-2}

Apples:...about 3kg cm^{-2}

Carrots:...about 20 kg cm^{-2}

Dark chocolate:...about 50 kg cm^{-2}

Fresh pine wood, in its weakest direction:...about 80kg cm^{-2}

In the present invention, the yield point of the B component or each of the B components should normally be no less than 200g cm^{-2} and more preferably not less than 500 g cm^{-2} while it should preferably be no higher then 150 kg cm^{-2}.

Extruded food structures in which distinct particles or phases of one material is randomly distributed in a matrix of another component are known e.g. from CH-A-0538814 (cheese), US-A-4697505 (chip cookies), US-A-3671268 and US-A-22313060 (ice cream), EP-A-0258037 and US-A-4358468 (meat) and EP-A-0775448 (caramel/chocolate). However the well-ordered structure of the present product, obtained by the special features of the method which is described below, enables an improved "taylor-making" of "mouth-feel" and taste.

It is further known to produce an individual encased food item or a single row or filament of encased food items, see e.g. EP-A-0246667, US-A-4,828,780, col. 9 lns. 43-58 and US-A-4,469,475. However, the character of such products are very different from that obtained by the present invention.

A in the final form of the product, at 20°C, may be in a liquid state. Alternatively A may be of plastic or viscoelastic character for instance in the form of a soft gel. A liquid or gel may comprise dispersed solids such as short fibres, nut, grain or shell-pieces, pieces of film or flake in a liquid or gel continuous phase, for instance aqueous solution or gel, or an oil. A liquid A may comprise a dissolved thickener. Another embodiment of A comprises an expanded material, such as formed by the presence of a raising agent in the

extruded material. The B component or B components should preferably belong to one of the following three groups of materials:

a) firm gels, optionally with inclusion of fine preformed solid particles,
b) bonded-together preformed solid particles,
c) fat-based materials like chocolate.

Preferably the compressional yield point YP_{B20} of B at 20°C is at least 500 g cm^{-2}, for instance in the range 500 g cm^{-2} to 80 kg cm^{-2}, generally less than 60 kg cm^{-2}.

The product A preferably is fluid, or is a gel or plastic or pseudo-plastic material which has a compressional yield point YP_{A20} at 20°C which is less than 1000 g cm^{-2} and more preferably less than 500 cm^{-2}.

In the present invention a gel is understood to be a three dimensional network formed of polymeric components, whether linked by chemical bonds or crystallites, or some other kind of junction, swollen by a liquid, which is generally self supporting, for instance when placed on a flat surface, rather than being fluid.

It is immediately understandable that the invention provides a new concept for achieving a food product which on the whole has a solid and mechanically stable consistency and nevertheless is pleasantly chewable and in all respects makes a natural feel in the mouth, be it a substitute of meat, a filled chocolate, another type of confectionery, a snack, snack-masked medicine, or a completely new combination of food ingredients. While A e.g. can be a continuous soft gel of plastic character within each platelet or lump, it is essential that B also can be a continuous gel, but in this case a firm gel.

Later in this specification the possible compositions of A and B will be further described.

Specific examples of the nature of components A and B are given in claims 25 to 38.

The short reinforcement fibres or grain-, shell or film-pieces or flakes in some of those claims in relation to components A and B are preformed, and are preferably but not necessarily digestible, or of value for the digestion e.g. short protein fibres. An important example of applicable shell-pieces (or husks) is

bran. They may contain absorbed aroma substances or the protein used for the fibres or film-pieces may have been brought to react with carbohydrate to form a caramel related compound.

As it is understood from the above, B forms "cell-walls" and A the "cell-contents". Typically the biggest average dimension of the cell is between about 1-30mm, and the smallest dimension about 0,1-3 mm. Due to the characteristics of the extrusion process, the cells are almost always of a curved shape, although exaggeration of such shape can and preferably should be avoided. The indication of the biggest dimension refers to measurements along the curved surface of the cell.

The cross section of cells of A in the xz plane generally has an average dimension in the z direction in the range 0.5 to 10 mm, preferably in the range 1 to 5 mm. Generally the cells of A have an average cross sectional area in the xz plane in the range 0.5 to 100 mm^2, preferably in the range 1 to 25 mm^2.

In the majority of the cells the thickness of the cell wall should preferably not at any place be smaller than 2% of the average thickness of the lump or platelet which is contained in the respective cell, since otherwise the mechanical stability may be insufficient. More preferably it should not be smaller than 5% and still more preferably 10% of the said average thickness.

In the invention the average row separation is preferably in the range 1 to 25 mm, more preferably 3 to 15 mm for instance 5 to 10 mm. Generally the boundary cell walls have a minimum thickness in the x direction in the range 5 to 50% of the average row separation, preferably more than 10 %.

The bridging cell walls, that is cell walls of B, between cells of A other than boundary cell walls, have a minimum thickness of 0.1 mm, preferably a minimum thickness of 0.5mm.

On the other hand, to give the product a suitable consistency, the average wall thickness in the majority of the cells should normally not exceed the average thickness of the cell of A.

In most cases when A is fluid, the nesting of A in B should preferably be a full encasement in three dimensions at least for the majority of the platelets or lumps. This is the more advantageous the more fluid A is.

adhesively with each other) are stated in claims 3 and 4 and illustrated in figures 1a and b, 6a and b, preferably exhibiting a compressional yield point which is at least double that of B1. More preferably the yield point YP_{B120} of B_1 at 20°C is in the range 0.1 to 0.5 of the yield point YP_{B220} of the B_2 at 20°C. Thus B2 may e.g. be tougher than B1 (in the final state of the product) depending on the method of manufacture and further dealt with later so that B1 easily is disrupted by the chewing to release the (tasty) A-, while the consumption of B2 requires more chewing work - which is felt as a good combination. Furthermore when B2' is less deformable than B1' in the state it has during and immediately after the dividing in the coextrusion process, B2' helps to achieve the most regular cell structure. (In this specification the extrudable material used to make A of the final product is referred to as A' during the process; likewise extrudable B' forms B after processing, B1' forms B1, B2' forms B2 etc).

These aspects are dealt with in connection with method claims

In one embodiment B1 is twisted around cells of A. The twisting can take place by the flow alone when the extrusive conditions for this are selected so that the segments of A' rotate. This is further explained in connection with fig 7a, b and c.

The boundary cell walls of B extending generally in the z-direction may be molecularly oriented generally in the z-direction. This is achieved by using suitable extrusion methods and apparatus. The orientation helps to make the product feel like meat when it is chewed.

The incorporation of a pulp of short protein fibres or pieces of protein film in A, has a similar purpose as the orientation and also purposes connected with the taste and nutritional value. Component A alternatively can consist of other short fibres or film pieces or of nut-, grain-, or shell-pieces, or flakes. Also in this connection, grain can be very suitable. When A is a cultured milk product, it can either be given sweetness and aromatic taste for use in the product as confectionery or dessert, or be spiced like "chutney" for products used in a first course or main course.

The incorporation of gas in the A cells is normally achieved by use of an expansion agent like the expansion of dough in breadmaking, or the expansion of vegetable protein with evaporating water in the conventional extrusion of meat substitute.

In bread or cake products, the B-component (cell-walls) based on protein serves to give the product a good mechanical stability even when the contents of the cells are very fragile (second grade flour or high contents of grain) or the product is very expanded. The use of cheese for the cell-walls is mechanically suitable and provides an interesting taste combination.

In an embodiment B is a microporous agglomerate of particles containing water in the pores, and the said particles consist of short fibres or grain-, shell- or film-pieces or flakes, which particles are bonded together by polymeric micro-strands, e.g. consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

In another embodiment, which may be a meat substitute, A comprises two separate components:

A1) a semi-solid fat or an oil based component containing the fat/oil soluble ingredients, and

A2) a juice containing the water soluble taste ingredients,

B) a component suitable for chewing.

In the first independent method claim (claim 44), a method is defined which is suitable for producing the new product (though not restricted thereto). In the method, cells of A are formed by extruding an extrudable material A' and coextruding an extrudable component B' which forms B and in the method flows of A' and B' are adjacent to one another in a direction transverse to z, the flows of A' and B' being regularly divided generally transverse to the direction of flow by a dividing member to form flows of A' and B' segmented in the z direction, a segment of flow of B' being joined upstream and downstream to each segment of flow of A. In the process B' is transformed to a harder material B after extrusion, the yield point for instance being at least 20 g cm^{-2}.

In the first aspect of the method of the invention, after exit from the extruder B' is modelled around A' segments so as to surround the A' segments

substantially completely in an xz plane. Furthermore, preferably A' is formed into at least two flows, and two rows of segments of A separated by a boundary cell wall of B are formed to form the novel product.

The claims further define a second method aspect of the invention. This aspect is defined in the second independent method claim namely claim 62. Preferably several flows of components A' are formed interposed with flows of B'. The dividing members reciprocate or rotate relative to the extruder exits to form segmental streams whilst modelling B' around A'.

The second method aspect of the invention may be used to extrude food products or may alternatively be useful for extruding other extrudable materials such as thermoplastic plastics materials. When the method is used for extruding food, preferably B' is transformed after extrusion to a material having a higher yield point as the first method aspect of the invention.

There are several ways of providing relative movement between the dividing member(s) and extrusion exits.

In one preferred method of the invention, the relative movement is provided by fixing the extruder components including the channels and exits, and moving the dividing members. For instance, the x direction may be arranged substantially vertically, with one or more flows of A' having flows of B' above and below, and to provide the extruder exits on a circular cylindrical surface having a substantially horizontal access. The dividing member is pivoted around the said horizontal access so that the dividing members reciprocate on the said circular cylindrical surface. One extruder suitable for putting this embodiment into effect is illustrated in fig. 11a and b.

Another way of carrying out the second aspect of the method invention, is for direction x to be substantially horizontal, and for flows of A' and B' to be arranged in a horizontal array, with flows of B' between flows of A', and with the dividing members reciprocating or rotating in a generally horizontal direction.

It is to be understood that the direction of extrusion of the component A' and B' is in a generally z direction, that is it should have a component of movement in the z direction. However it may additionally have a component of movement in the x or y direction. Furthermore components A' and B' may be

provided with movement in a direction having components of movement in the same or different x or y directions.

Whilst the invention has been described, and is described in the following description as being from a conventional flat-die, with components and directions defined by reference to an orthogonal coordinate system based on the x, y and z axes, the dies may alternatively be circular, in which case the coordinates could alternatively be replaced by r, θ and z. The direction of extrusion, that is of flow of A' and B' from the extruder exits may be in the z direction, the r direction (either inwardly outwardly directed) or substantially the θ direction. Where the extrusion is in a generally z direction or generally r direction, the dividing members preferably rotate or reciprocate in the θ direction. Where the material exits from the extruder in a r direction or θ direction it may alternatively be possible to reciprocate the dividing members in a z direction. Apparatus adapted from the inventor's earlier apparatus described in US-A-3,511,742 or US 4,294,638, both based on circular dies, could be utilised in such embodiments.

This type of coextrusion belongs to a "family" for which the inventor in the past introduced the name "lamellar extrusion". This signifies a coextrusion method by which two or more extrudable components first are interspersed with each other in a sheet-like array of flows which then are mechanically sheared out by means of transversely moved dieparts in a way that produces a sheet of thin lamellae - continuous or discontinuous - which are positioned at an angle to the main surfaces of the sheet.

To the knowledge of the inventor the only published inventions within this "family" are contained in French patent no. 1,573,188 issued to Dow Chemical Limited., and those patented by the inventor of the present invention, comprising the two U.S. patents mentioned in the introduction to this specification (and counterparts in other countries), and further, referring to U.S. patent numbers, the following: 3,505,162; 3,511,742; 3,553,069; 3,565,744; 3,673,291; 3,677,873; 3,690,982; 3,788,922; 4,143,195; 4,294,638; 4,422,837; and 4,465,724.

Only the two patents mentioned in the introduction to this specification by the present inventor disclose the use of lamellar extrusion for manufacture of food products, and as mentioned the components are not formed in to segments according to these disclosures. The disclosures in the other patents are limited to synthetic polymers with a view to the manufacture of textiles or textile-like materials, and in a few cases reinforced board materials. The modelling of one component around segments of another component is not disclosed, neither is there disclosed any formation in these synthetic products of a cell structure comparable to the cell structure dealt with in the present invention.

EP-A-653285, which has been mentioned earlier in this specification, uses the interspersion method disclosed in the above mentioned US-A-3,511,742 and in several of the other above mentioned patent specifications, to produce a multi-layered food product in sheet or plate form. The layers are not "lamellae" but are parallel to the main surfaces of the sheet/plate and are not broken up into segments.

For establishment of the cell structure according to the invention it is essential that the segments of B become modelled around the segments of A. One way for achieving the modelling is by requiring that the B' under the process conditions has a viscosity, and yield point if any, which is significantly lower than those of A'. Preferably the viscosity and or yield point is less than 0.5 the viscosity or yield point, as the case may be, of A under the process conditions. A further improvement is achieved by minimising adhesion of the A' to the dividing members by incorporating an oil or fat in A'.

An alternative or supplementary way of achieving the modelling of B' around A' is by merging the flow of A' with a flow of B' on each side (in the x direction) prior to the extruder exit. This embodiment will be described in more detail below.

At the time of dividing, A' should preferably not be liquid, but can be plastic, pseudoplastic, gelformed, can be a dry powder or in other way a particulate material. In each case it means that, very generally speaking, a

certain minimum value of shear force is needed to cause permanent deformation under the conditions in the die.

B', on the other hand, (or B1' if there are two B-components in the arrangement shown in fig. 1a and 6a) should at this stage of the process be of a fluid to plastic consistency and generally exhibit a lower resistance to permanent deformation. It should preferably have plastic consistency in order to make the extruded product self-supporting as it leaves the die.

The ways of interspersing the components with each other and to carry out the movements which cause the dividing of the flows of A' and B', may be based on the patents on lamellar extrusion, which are listed above.

As well as effecting a relative recprocation between the channels and orifices on the one hand and the dividing members on the other hand, it may be advantageous to provide for a relative reciprocation or rotation between the row of dividing members and the exit chamber,(which is known *per se* from the mentioned patents). This serves to arrange the filaments in the final product in a generally transverse direction (if this is wanted) and/or to increase the bonding between the filaments.

In order to optimise the shaping of the segments in the dividing process this should preferably take place by shear between on one side the internal orifices through which the mutually interposed narrow flows are extruded, and on the other side the row of dividing members, and furthermore best by cutting action (see claims 79 and 80). The different ways of realising the cutting are specified in claims 81 to 83. Examples of the shape and positioning of the knives for this action are shown in figures 7a and 9. By means of the severing action and/or the "microsawing" specified in claim 83 it is possible to form very fine slices of the components even when these contain pulp or fibres.

The dividing of the narrow flow to segments is preferably carried out in rhythmic operations with the dividing members acting as shutters (i.e. being of a width so as to be able to completely shut off the orifices), and furthermore with at least component A' extruded in pulsations such that maximum driving force of the material A' through the channel is imposed while the orifices for A' are open. These features are shown and further explained in connection with

figures 8a, b and c and figure 12. The pulsations may be produced by a ram for each narrow flow of the component, localised at the entrance to the chamber for the narrow flow - see figs. 8a, b and c - and optionally extending into the chamber. It depends on details of the process and the choice of component whether the flow mainly will be caused by the conventional feeding means (e.g. a pump or an extruder) optionally in combination with intermittently operated valves or by the above mentioned rams.

The use of intermittent extrusion in connection with lamellar extrusion is known, with other aims, from the above mentioned U.S. Patent No. 3,788,922 see col. 2, lines 51-64, col. 3, lns 4-13, col. 4, lns. 45-53, example 1 and example 2. This patent discloses the use of shutters to achieve the intermittent extrusion, but does not disclose that the dividing partitions can be used as shutters. Furthermore it discloses the use of a vibrating piston to cause the pulsations, but this is a piston between the extruder and the die instead of (as in the embodiment of the present invention) one ram (piston) for each narrow flow and installed in the die itself.

A very advantageous way of achieving the modelling of B' around the segments of A' is stated in claim 70 and a preferred embodiment is stated in claim 71. Generally speaking, two generally yz surfaces of each segment of A' are covered mainly by the part of B' which is joined with A' prior to the dividing, and the two xy surfaces of the segment of A' is covered mainly with B' from those internal orifices which carry B'-component alone. This provides improved possibilities for controlling the thickness of the B' layer in contact with the dividing member.

A modification of this embodiment of the method comprises the use of two B'-components B1' and B2'. It is specified in claim 72 and shown in principle in fig. 6a and b, and with further details of the entire extrusion in other drawings as will become apparent from the detailed description of the drawings. In connection with the description of product there has already been discussion of the advantages of this modification, and it was mentioned that, provided B2' is less deformable than B1' in its state during and immediately after the dividing, B2' helps to achieve the most regular structure. This should be understood so:

B1' should normally be easier to bring to flow than A1'. However, the higher flowability will mean that the backpressure tends to squeeze B1' towards the walls of the dividing members, whereby the "boundary cellwalls" may become thicker than wanted, while the "bridging cellwalls" may become thinner than wanted. The use of B2' component which shows more resistance to flow than B1' can fully solve this problem. B2' can also, if wanted, have exactly the same composition as B1', but be fed into the extrusion apparatus at a lower temperature to give it higher resistance to deformation, e.g. it may be semifrozen.

It has already been mentioned that in many cases the nesting of the segments of A' in B' is most advantageously a full encasement. The method of the invention comprises two alternative embodiments (which can be combined) to achieve such structures, one being stated in claims 91 and 92, and illustrated in figs 7b and 11b. The use of internal orifices which extend or are interrupted is dealt with here is known from the inventor's earlier patents on lamellar extrusion, but neither for the purpose of producing food products nor for production of any cellular structure comparable in geometric to the structures of this invention.

After the extrusion process, component or components B' must be transformed to a firm cohesive form (optionally this transformation may already start before the dividing process) while component A' may remain generally as it was during the dividing, or be transformed either to become more "fluid" or become expanded.

The alternative options for transformation of B' (which may in some cases be combined) are stated in claims 46 to 60.

In preferred embodiments of the method B' is transformed to harder B by cooling, normally after melt-extrusion. Examples are:chocolate, swollen soya protein or gums. In some cases, when the process is sufficiently slow, e.g. consists in the formation of a gel, cooling of a fluid or plastic solution formed at a relatively high temperature e.g. about 100 °C can be carried out prior to the extrusion, which then can be established at normal ambient, or lower temperature. Examples: adequately strong colloidal solutions of gelatine,

carregenin or Ca-pectinate. Examples of solidification effected by heating of a colloidal solution: adequately strong colloidal solutions of egg albumin or gluten (or gluten-reinforced dough). Examples of reestablishment of the continuity in a previously disrupted gel are: a thixotropic colloidal solution of carregenin with addition of potassium ions (reestablishment on storage for a short time); heating/cooling of disrupted gels of casein or soya protein or starch.

It may be possible for the transformation of B' to B to be the formation of a firm gel by a chemical reaction which is sufficiently slow to allow mixing of the reactants (in B') prior to the coextrusion. The reactant may be incorporated into solid particles suspended in B'. As an example, colloidal solutions of pectin or alginate, with additions of Ca-ions and an enzyme which gradually demethylates the polymer, whereby the Ca-salt precipitates as a gel, would be suitable. Another example of an enzymatic reaction involves a protease such as rennin to break down and coagulate milk protein.

Another way of carrying out the transformation to harder B is the formation of a firm gel by chemical reaction between reactants in the B'- and A'-components for instance so that reactants in A' gradually migrate into B'. To gel a B' component which is a colloidal solution of demethylated pectin or alginic acid, there may be used as reactant in the A-component ions of Ca, Mg or Al. Coagulation by change of pH can also be used. As a precaution to fully secure that internal orifices are not blocked by such gel formation, the letter may be adapted in a way which requires a simultaneous change of pH and introduction of such metal ions. In such cases there is used two channel systems for component A', one to carry the said metal ions and introduce it into the B'-"cellwalls" from one side, and the other to change pH from the other side of the B'-"cellwalls".

Depending on details in the parameters of the extrusion process, a B'-component in form of a colloidal solution may become molecularly oriented while it flows towards and through the internal orifices and proceeds along the walls of the dividing members. This orientation can be "frozen" if the gel formation by use of a reactant from the A'-component is sufficiently fast. The material of B is thus often oriented in the boundary cell walls to be directed in

the generally z-direction. The "frozen" orientation can help to make the product feel like meat when it is chewed.

As another means for transforming B' to a harder material B preformed solid particles are coagulated to continuous firm matter: fine disperse particles of soyaprotein in a solution containing Ca-ions. The particles may be short fibres, in particular flat fibres which may be so short that they are platelets. For economical reasons flat fibres or platelets from expanded, oriented, fibrillated protein film is preferred. This is particularly useful for the B2'-component in the structure shown in figs. 1a and b, 6a and b, as made by the apparatus shown in fig. 8. The protein from which the fibres are formed may have been brought to react with a carbohydrate at an elevated temperature to form caramel-related compounds. When there are two B-components B1' and B2', arranged as explained in the foregoing, one method of giving B2' the desired consistency before the dividing (cutting) process, is to form B2' into a gel, at least in part, while it proceeds as narrow flows towards the dividing (cutting) process. This can in some cases be done by admixing a reactant immediately before B2' reaches the channels for the narrow flows, and in some other cases by high frequency heating while B2' proceeds in the narrow flows towards the array of internal orifices.

Keeping in mind that A in the final product must be more flowable or contain gas, A may in some cases remain in the same generally plastic, pseudo plastic or viscoelastic state which it had (as A') during the dividing and modelling processes, but in most cases it should be transformed to a more flowable form, especially when a juicy performance is wanted in the mouth when the "cellwalls" have been broken by chewing.

When A' has a high content of water, there are two ways of making A' adequately semisolid to solid during the dividing (cutting) and modelling process steps, and later more flowable. One way is by freezing and later melting an adequate part of the water or crystallizing sugar and/or other substances dissolved in the water, and later letting it dissolve or melt again. Another way is by use of depolymerisation (hydrolyses) after the extrusion process, preferably by enzymes, such as protease enzymes.

When A' is in frozen or preferably part-frozen state during the extrusion, freezing of B should normally be avoided, except in the case that the or one of the B' components is also to be cooled to below or about the freezing zone, but B' should preferably prior to the extrusion be cooled down almost to its freezing point and the extrusion process should be carried out as fast as practically possible. The chambers for the narrow flows, and the row of dividing members should in such cases normally be made from metal and then kept at a temperature near the freezing point of B'. Melting of a film from A' during the passage through the die will normally be advantageous rather than harmful, because of the lubrication effect, provided the extrusion velocity is sufficiently high and this film therefore thin.

In order to keep the icecrystals bonded together to an adequate plastic consistency, there should preferably be some amounts of sugar or a watersoluble polymer (e.g. guar gum or partly depolymerised protein) mixed into the A'-component, and dispersed short digestible fibres are also helpful in this connection.

When leaving the die the product will normally be supplied to a conveyor belt or directly collected in trays and may before this collection or on the belt be cut into suitable pieces. The faces where it has been cut ("the wounds") may be sealed if desired or necessary (to prevent leakage of fluid A) by conventional means. Optionally the entire piece may be enrobed e.g. in a thin film of chocolate.

~~If the transformation of B' to a firm form B is carried out by heat~~ treatment, this treatment is best done while the product is on the conveyor belt or in the abovementioned trays, and can be by means of microwaves, high frequency heating, contact-heating or by hot air.

Dividing of the extruded continuous product into longitudinal segments can be rationalised. E.g. the extrusion of A'- component can be stopped during time intervals long enough to produce a transverse band of plain B components through which the product can be cut without making a "wound". Alternatively the extrusion of B' can be interrupted during time intervals long enough to produce a transverse band of plain A-component, through which the continuous

2) A: during the extrusion: soya flour dispersed in water thickened by means of part-hydrolysed soyaprotein, and with spices and other aromatic substances, plus proteinase added - after the extrusion: hydrolysed by the proteinase.

B: see I) 3).

IV) Cellular products with contents like sausages.

A: a paste as normally used in sausages, optionally with addition of part-hydrolysed soyaprotein as a thickening agent.

B: see II) 2), or I) 3) or a firm starch gel, disrupted before the extrusion and regenerated by heating/cooling.

This is e.g. a new and advantageous way of using 2nd grade products from the slaughteries.

V) Bread or cake like products.

A: Conventional dough with expansion aid.

B: See II) 2)

The product is baked, whereby the cell structure helps to obtain a fine and even expansion.

The invention will now be explained in further detail with reference to the drawings. In several of the figures there is shown a system of coordinates x, y and z. These coordinates correspond to the indications in the claims and in the general part of the description.

Fig. 1a and b show in the x-z and x-y sections, respectively, of a particularly regular arrangement of the row structure according to the invention with A as "cells" and B1 and B2 as "cellwalls".

Fig. 1c and d show in x-y section two different modifications of the arrangement shown in figs. 1a and b.

Fig. 2 shows, in x-z section, an A/B "cell structure" in a less regular arrangement of the rows, but still falling under the product invention.

Fig. 3 shows in x-z section, a type of A/B-structure which normally should be avoided, but can be useful in cases where the visual effect is most important.

different from what is shown in figs. 8a, b and c, but suitable for producing similar products. The drawing does not show the entire extrusion device.

Fig. 11a and b show, in sections x-z and y-z, respectively, another embodiment of the methods and apparatus suitable for making the same kind of products. In this embodiment the dividing movements and the x-direction are generally vertical, while the y-direction is generally horizontal.

Fig. 12 shows in detail the four different positions between the reciprocative movements by which the dividing takes place in the apparatus of figs. 8a, b and c. This figure is made in support of the description of a program for coordination of the different movements and stops.

Fig. 13 represents the test apparatus for determination of compressional yield points.

The typical cell-like structures of the invention, shown in figs. 1a and b are first formed as segmental "filament" structures (see e.g. figs. 4 and 5), and several such "filaments" are then joined to "ribbon" or "sheet" form. The dotted lines (1) indicate the borders between the filaments, where the bond may be so weak that the filaments easily separate from each other in the mouth. This can be advantageous, but the B-material from two neighbour filaments may also be so intimately connected that the borderline hardly can be found in the product.

Referring to the terms in the claims, (2) are the boundary cell walls, (3) the rows of A-cells, (4) the bridging B-cell walls extending generally in z y planes and x y planes, and (5) the bridging B-cell walls extending generally in the x z plane.

These drawings show the presence of two B-components, B1 and B2, of which B1 mainly occupies the boundary cell walls (2) and the bridging cell walls (5) which extend generally in the x z plane, while B2 mainly occupies the bridging cell walls (4) which extend generally in z y planes and x y planes. However depending on the construction of the apparatus (see later), (2) and (5) may also each be partly B1 and partly B2. There are different reasons for using two B-components. One which later will be discussed concerns the manufacturing process, but to this comes that relatively soft or fragile boundary cell walls (2) give a quick release of a fluid (tasty) A-component in the mouth,

while relatively tough bridging cell walls (4) give extra chewing work after release of the tasty component. Both of these effects are felt pleasant in the mouth.

However, still with reference to figs. 1a and b, B1 can be identical with B2, i.e. there will be only one B-component. It will become clear from the apparatus drawings with connected description how these different products can be made.

In figs. 1c and d the rows of A-cells are mutually displaced in two different ways. The manufacture of these structures are briefly mentioned in the descriptions to figs. 7a +b +c, and 11a + b, respectively.

Depending on the rheology of the components during the extrusion, the length of the A'-segments cut, and other details in the extrusion process, the structure of the final product may deviate considerably from the regulatory shown in figs. 1a to d, but still fulfilling the purposes of the product according to the invention. Fig. 2 is an example of such less regular structure. It should be mentioned that the cells also can be made almost spherical, namely by causing each small lump of A' to rotate in the exit part of the coextrusion die. This is further explained in connection with figs. 7a, b and c.

In fig. 2 the cells have a relatively pronounced curved shape (pointing in the direction of extrusion) which is a result of dragging during extrusion. Even in the almost ideal structure of fig. 1a there is shown some curvature. Such shapes or "deformations" of the structure are normally not intended but almost unavoidable due to the friction while the segmental stream passes between the dividing members (and show that the product is an coextruded product). However, if such deformations are exaggerated as shown in fig. 3, they may be harmful. This can happen by inadequate choice of rheology for one or more of the components and/or insufficient modelling of B' around the segments of A'. One of the product claims states preferable limits for the "deformations" in the B-structure. The reference to thicknesses in this claim is illustrated in fig. 3 as follows:

the smallest local thickness of a branch in the vicinity of the branching-off is shown with arrows (6), the smallest thickness of the boundary cell-wall in

Figs. 7a, b + c further serve to show how to form the bridging B cell walls which extend generally in the xz plane - indicated by (5) in fig. 1b. Right at the end of the internal orifices for the B1'A' B1' and B1' B2' B1' flows there are ribs which are seen in profile as (14) in fig. 7 b, and seen towards their downstream ends as (15) in fig. 7c, while their upstream edges are shown as the dotted line (16) in fig. 7a. As fig. 7b indicates, these ribs are not sharp edged but plane in the downstream end. Corresponding hereto there are ribs in the exit part (44), shown in profile as (17) in fig. 7b. These ribs are sharp in both ends, the sharp edges at the upstream end being shown as dotted lines (18) and (19) in fig. 7a. It will be explained below how these ribs in the row of internal orifices and in the exit part serve to shape bridging B1 cell walls inside the product. Similarly, the "ridges" (20) at the ends of the internal orifices and corresponding "valleys" (21) at the entrance to the exit part (see fig. 7 b) serve to form layers of B1 on both surfaces of the final product.

While each channel for B1' branches out to feed into an A' channel on one side and into a B2' channel on the other side, it also proceeds straight forward to feed directly into the exit part ending in 4 slots (21 in fig. 7c) the length of which in x-dimension corresponds to each opening into the exit part, while the position in y-level corresponds to the levels of ribs (17) or "valleys" (21), as the case may be.

When the reciprocating movement is stopped in the position where the B1' component is fed directly into each chamber in the exit part, while the internal orifices for the B1'-A'-B1' flows and the B1'-B2'-B1' flows are blocked by the dividing members (10), the "valleys" will become filled with B1' component, and similarly the upstream part of the ribs (17) will become fully covered with B1'. After the following step of reciprocation, a B1'-A'-B1'- flow or a B1'-B2'-B1'-flow (as the case may be) will be fed into the chambers in the exit part (the internal orifices for direct B1' extrusion being blocked), but due to the geometry of ribs (14) and (17) and "ridges"/"valleys" (20) and (21) these flows will never get in contact, either with ribs (17) or with the xz surfaces of the chambers in the exit part. These ribs and chamber surfaces will all the time be

covered with B1' and will therefore create "bridging cell walls" of B1' in the final product.

By making adjacent dividing members (10) and/or adjacent ribs (17) of mutually different lengths, and at the same time suitably adjusting the length into which the flows are cut, it is possible to make the segments of A' rotate and acquire a generally cylindrical or spherical shape.

Figs. 7a, b + c show the most complicated but usually also best method of treating the flows. However, the individual features which are presented here can of course be used in other combinations. Thus the use of springy membranes (13) and of ribs etc. are two different features which are not necessarily combined. And further the coextrusion of B1' into the B2' flow - which requires that A' and B2' have practically equal yield points - and the direct extrusion of B1' into the channels in the exit part may both be omitted. In that case there should not be any ribs (14) and ridges (20) in the B2' channels, and therefore it will become B2' which covers the ribs (17) and the xz surfaces of the chambers in the exit part.

Finally, fig. 7b shows the transport belt (22) which takes up the extruded product, and on which there normally are carried out further operations. It also shows a flap (23) which should be adjustable. This is not mandatory but can be a help for adjustment of the back-pressure in the exit part to avoid on one hand the occurrence of cavities in the extruded product, and failing flowing-together of the segmental streams in the exit part (44), and on the other hand an exaggerated pressing flat of the segments of A' components.

By modification of the dividing members (10) shown in figs. 7a + b, the apparatus can be made to produce the structure represented by fig. 1c. For this purpose the upstream edges on (10) should still be straight and generally perpendicular to the plane defined by the array of flows, but after the dividing, the different "levels" of segmental flows should gradually become staggered ("level" meaning this space between two adjacent ribs (17) or a "valley" (21) and the adjacent rib (17)). The downstream edge of each dividing member (10) must have a staggered shape corresponding to that wanted in the product, and the sidewalls of (10) will gradually adapt to this shape. Normally the staggering

of the construction should not extend over the full x-dimension of the apparatus and the product, but should be zero at the sides of the apparatus and at the x-boundaries of the product.

Figs. 7a + b can also illustrate the manufacture of a product having two different series of "cells", A1 and A2, and only one component B for the "cell walls", in other words the designations A', B1' and B2' in the drawings should be substituted by A1', B^1 and A2', respectively. However in that case each of the internal orifices for B in the row of orifices shown in fig. 8c should not be interrupted as in this drawing. One of the two A components may e.g. be waterbased and the other one fat/oil based, while B in the final product normally should be a gelled composition.

The total coextrusion die represented by figs. 8a, b + c, consists of a stationary inlet part (24), a reciprocating "interpositioning part" (25) with chambers for the interposed narrow flows defined by walls (26) and ending in the array of internal orifices defined by elements (9), and a fixed exit part supplied with dividing members (10). The "interpositioning part" (25) is guided by tracks 102 in the fixed base plate 101. The reciprocation is indicated by the double arrow (11) but the means for this reciprocation are now shown. The apparatus is normally installed in such way that the section shown in fig. 8b is really horizontal or close to horizontal. The three components A' (for "cells"), B1' and B2' (both for "cell walls") are extruded from the inlet part (24) through 3 relatively long and narrow orifices (27 for A', 28 for B2' and 29 for B1') by conventional means, i.e. by pumping or extrusion. The apparatus for this are not shown. The inlet part (24) is outside the section shown in fig. 8b, but the position of the walls for the A'-chamber, the B2'-chamber and the B1'-chamber in this part are indicated by the dotted lines (30), (30a) (31), (31a), and (32a), respectively. Prior to or in connection with the conventional pumping or extrusion, each of the components is intimately blended and given the appropriate plastic condition, normally by semi-melting or semi-solidification (the latter as in the manufacture of ice-cream). Since the rheological properties in such semi-molten or semi-solidified state may depend very critically on the temperature, temperature-control may not be sufficient, but a constant

measurement of the apparent viscosity may be needed for feed-back control. The temperatures in each of the 3 components - which may be different temperatures - are maintained during the passage through (24) by a circulating heating/cooling liquid. The system for this is not shown. Similarly, there is kept appropriate temperatures in the reciprocating part (25) and in the exit part, the heating/cooling means for which are not shown.

The flow of components through each of the 3 exits from the stationary feeding part (24) is not constant, but is made intermittent by means of a pressure varying device, e.g. hydraulic cylinder (33) connected to each flow (but only one is shown in the drawing). For each component the minimum pressure is close to zero, while the maximum pressure may be several hundred bars. There is a steady measurement of pressure in each component with feedback to the pump/extruder so as to secure that the maximum pressure becomes almost the same in each stroke. (Devices not shown). The pressure is raised while the chambers in part (25) become filled. During that period the reciprocation of (25) is stopped, and two clamps (e.g. hydraulic clamps) of which one is shown as (34) in fig. 8a, secure a tight sealing between the 3 exit slots of part (24) and corresponding rows of openings in the inlet plate (24a) on part (25). After reduction of the pressures in the 3 components almost to zero, the sealing between parts (24) and (25) is released - clamps (34) should only move a fraction of a mm to achieve this - and the "modelling" processes, including the reciprocations of (25), are started. These processes are further described below. Later on the firm sealing is again established and pressure applied to feed the channels in (25).

In the reciprocating "interpositioning" part (25) there is a number of narrow channels for A', B1' and B2', respectively. In fig. 8b it is written in each channel which component it conducts.

These are closed channels, except at their exit end and except for the above mentioned rows of openings in the inlet plate (24A) towards the corresponding orifices in the fixed inlet part (24). Thus, since fig. 8c shows a section which goes through one of the A'-channels in the reciprocating part, it

there is installed a non-return valve (43), shown in cross-section in fig. 8c. Seen in x-direction these 3 valves extend in the full length of the exits (27), (28) and (29). They prevent any substantial loss of material by backflow which otherwise would occur when the cylinders (34) partly have eliminated the sealing between part (24) and part (25). Likewise, the sealing of the connection between the reciprocating "interpositioning part" (25) and the exit part (44) with the dividing members (10) must be firm while there is extruded through this connection and while the rams are moved backward during a filling period. However, this sealing must be much looser while (25) is in movement, otherwise the friction may become a problem. The hydraulic clamps (45) take care of the tightening and loosening of this sealing by movement amounting to only a fraction of mm. The abrupt reciprocating movements of (25) which are indicated by the double arrow (11) - can conveniently but not necessarily be established in fully mechanical way by means of a cam (not shown). This is further explained in connection with fig. 12.

In addition to components A', B1' and B2' there is also, in smaller amounts, used a component C for lubrication of the rams. This is applied under pressure in conventional way, but the means for this are not shown. C must of course be conveniently compatible with the other components, i.e. it must not ruin the mechanical stability of the final product, and it must be suited for food applications (see the examples).

The conveyor belt (22) which already has been mentioned in connection with fig. 7b, is preferably advanced abruptly with stops corresponding to the short periods (e.g. 0,5 sec.) while the channels in part (25) receive material from part (24).

At the position where the coextrusion device delivers the product to the conveyor belt, there may be a knife for cutting the product into convenient lengths (not shown), and there may also be other devices in connection with the conveyor belt, e.g. for heat treatment of the product.

In many cases the packing of the product can take place on this conveyor belt, and to do so a packaging film can be laid on the belt before this receives the cut-out piece of product. This film can be automatically wrapped

over each piece, and if the belt is accelerated for a short moment after each cutting action to separate the pieces from each other, the wrapping can be done from all 4 sides. If the packaging film is an aluminium film, this can sufficiently support the product during the solidification of the B'-component or - components (solidification by heating or simply by storage).

Coordinated with the cutting at the entrance to the conveyor belt, the extrusion of A'-component may be interrupted for a short period, while there still is extruded B'-component or - components, so as to secure that the cuts traverse B' only. This is advantageous if A in the final product is fluid.

"Bleeding" of A-component from the ends of the product pieces can alternatively be avoided by a conventional coating of the cut ends or of the entire product (e.g. with chocolate or similarly) preferably while the product is frozen.

It should be mentioned that the use of a conveyor belt is not always needed. Furthermore the hydraulic clamps (34) and (45) (or similar non-hydraulic clamps) and the non-return-valve (43) are not indispensable but are very useful for achieving a high throughput.

Instead of establishing the pulsating extrusion by means of rams, it can also be done under use of a valve arrangement as shown in fig. 8d. Between the fixed inlet part (24) and the reciprocating "interpositioning part" (25) there is inserted a shutterplate (46), which also follows the movements of (25) indicated by the double arrow (11), but superposed on this movement, (46) is driven forward and backward relative to (25) - see double arrow (47) - by means of an actuator fixed to (25) (not shown). In firm connection with (25) there is a coverplate (48). Both shutterplate (46) and coverplate (48) have 3 rows of slots, (49) for the A'-component, (50) for the B2'-component, and (51) for the B1'-component. These slots in (48) correspond exactly to the respective channels in (25), and the slots in (46) exactly match those in (48) when the shutter stands in position "open", while the shutterplate completely covers the slots in (48) in position "closed". Before this shutter arrangement there is not installed any devices to produce pulsations in the extrusion pressure. This

system is mechanically simpler than the ram extrusion, however due to frictional problems it is slower.

If one shutterplate is used for all 3 components, they will of course be extruded in the same rhythm, but it is also possible to use one shutterplate for each component.

By means of the modification shown in fig. 9, the dividing of the flows will take place by a very efficient "severing action" and it will even be possible to divide flows which contain fibres longer than, say 2 mm. Since the channels in the exit part are biased, seen in relation to the z-direction of the apparatus, the take-off of the product from the device by means of a conveyor belt must similarly be biased.

The drawing represents a modification of the simple "modelling" shown in fig. 4, but this type of "severing action" can also be applied to the more complicated methods of "modelling", even to the method shown in figs. 7a, b + c.

In the embodiment represented by fig. 10, there is a separate "ram-part" (52) for the ram extrusion, and in this part there is one ram only for each component A', B1' and B2', namely rams (53), (54) and (55) respectively. This "ram-part" is a fixed part like the "feed-part" (24), and the feeding takes place through slots (56) for A', (57) for B1' and (58) for B2'. In order to allow the passage of B1' into the middle chamber of the "ram-part", the ram (55) is also supplied with a slot (59) or with a row of slots.

The "feed-part" (24), which is not shown here, comprises hydraulic pressure varying devices and no-return valves like (33) and (27) in figs. 8a + b, but since the "ram-part" (52) does not move, there is no hydraulic clamp like (34).

The reciprocating "interpositioning part" (25) - reciprocations indicated by double arrow (11) - which slide upon the "ram-part" (52) intersperse the 3 components and bring them into array by means of the converging channels (59').

The drawing ends where the flows have been brought into array, but in actual fact this embodiment also comprises devices for the dividing and

b) 9 instead of only 2 sets of ribs (14) and (17), now to form vertical "cell walls". (This number can of course be varied).

c) B1' forming a conjugent flow with A' only and not being directly passed into the exit part. (This is not essential for the embodiment).

Like in the other embodiments of the invention there are clamps (45) i.e. hydraulic clamps (45) adapted to firmly press the exit part towards the preceding part when efficient sealing is needed, and loosen the connection during the periods of relative movement between the parts.

The structure shown in fig. 1d can be produced with this embodiment of the apparatus of the invention, when suitably modified. The ribs (17) in the exit part (44) should not point straight in the machine direction, but in the "upper level" e.g. point to the right and in the "lower level" to the left. This leads to the formation of two mutually displaced rows of cells. To achieve three mutually displaced rows as shown in fig. 1d the exit part must have three inlets instead of only the two which are shown. Near the left and right edges of the extruded product the displacements should be near zero.

The following will explain in detail the programme for operating the coextrusion and "modelling" process, when the apparatus shown in figs. 8a, b and c is used. Fig. 12 shows the different stop-positions of the reciprocating "interpositioning part" (25) relative to the fixed "exit part" (44) (Figs 8a to c indicate the reference numerals). There are 4 such stop positions, namely:

<u>Position I</u>, in which the upstream ends of the dividing members (10) cover the ~~entire row of internal orifices defined by the members (9),~~ so each of the 3 sets of flows (B1' A' B1'), B1' and (B1' B2' B1'), respectively, are stopped, and any retraction of material from the channels in the exit parts also is prevented, provided there has been established a firm sealing between the two apparatus parts (25) and (44) as achieved by means of the hydraulic clamps (45).

<u>Position II</u>, the symmetrical position, in which there is free passage for all plain B1' flows into the exit part (44) and is shut-off for all of the (B1' A' B1') and (B1' B2' B1') flows, still provided a firm sealing has been established.

<u>Position III</u>, the position in which part (25) is most to the left, and in which there is free passage into the exit part (44) for all conjugate flows (B1' A' B1') and (B1'

B2' B1') except the farthest right (B1' B2' B1')-flow (which threfore must not be acted on by a ram), and is shut-off for all plain B1'-flows, still provided a firm sealing has been established.

Position IV, the position in which part (25) is most to the right, and in which there is free passage into the exit part (44) for all conjugent flows (B1' A1' B1') and (B1' B2' B1') except the farthest left (B1' B2' B1')-flows (which therefore must not be acted on by a ram), and is shut-off for all plain B1-flows, still provided a firm sealing has been established.

If in any given chamber in exit part (44) the extrusion during stops in position III will inject a piece of a (B1' A' B1')-flow, then the extrusion during stops in position IV will inject a piece of a (B1' B2' B1')-flow in the same chamber (and *vice versa*).

Starting situation for the following program is a situation in which (25) has been brought into position I, hydraulic clamps (45) and hydraulic clamps (34) both are under pressure to make firm sealing between the "inlet part" (24) and the "interpositioning part" (25), and between this part (25) and the exit part (44), and furthermore each of the rams (35) are in their foremost position, while the pressure in the inlet part (24) is close to zero in each of the 3 components, as regulated by the hydraulic pressure variating devices (33).

1st sequence of steps: The pressure in the inlet part (24) is increased in each of the components by means of the devices (33) so as to inject each of the components into the channels of part (25) and drive each of the rams (35) to its most backward position. If the rams are adapted to be positively pulled backward (which they are not in the construction shown in fig. 8a and c), this pull should also be activated but should be stopped when the farthest back position has been reached. After this devices (33) bring down the pressure of each component in the inlet part almost to zero, then the hydraulic clamps (34) and (45) release the two sealing pressures to allow part (25) to be moved, whereafter (25) is moved to position II. Finally clamp (45) is activated to establish a firm sealing between part (25) and part (44) (but clamp (34) is not activated).

established through a sliding or spring coupling, while the short stops of rotation of (25) are established by the hydraulic clamps (45) and additionally further brake devices.

Although the extrusion methods and apparatus of the invention primarily have been developed with a view to coextrusion of cellular foodstructures the "modelling" of B' around A' by a suitable coordination of extrusion in pulses and relative movements of dieparts, can find other important uses in connection with extrusion of cell-formed polymer products or ceramic products. In such cases the nesting of A in B normally should only be in two dimensions, in other words A should extend from one major surface of the product to the other major surface. The cell structure may serve decorative purposes, when A and B have different optical properties, or if A can be fully or partly removed after the extrusion. A can e.g. be paste which can be leached out. The cell structure may also have a real technical function, e.g. in the manufacture of catalyst products, where A can be a porous material e.g. ceramic material containing the catalyst, and B,, e.g. also ceramic, can act as reinforcement in all 3 dimensions.

As mentioned in the introduction to this specification there does not, to the knowledge of the inventor, exist any official standard for measurement of compressive yield point. Neither does there exist any commercial equipment for such measurements, when the sample to be tested is only about 1 or a few grams as needed in practice for the measurements on a stack of B "cell-walls" cut out the final product of the invention. It was therefore necessary to construct a test device and decide on the conditions of testing.

Fig. 13 shows the device. The sample (61) is placed on a metal base (62) which is supplied with cooling/heating and temperature controlling means for the testing of semi-frozen or semi-molten A' and B' components. The device has a square foot (63) (dimensions see below) and is pressed into the sample by means of a piston operated by air, the pressure of which can be exactly adjusted to give a well defined and variable pressure on the sample. The penetration of the foot (63) into the sample is shown by the indicator (65) which

with an intermittently operated stamp as shown by (33) in figs. 8a and c. Joining of the flows: in all examples conjugent B1' A' B1' flows, but no coextrusion on the sides of the B2' flows, as shown in figs. 6a and b. Use of the membranes (13) shown in fig. 7a, except in examples 2 and 5, where the yield point of B1' is lower than but relatively close to that of A'. (In the other examples the difference is much bigger).

Experiments in preparation of the examples: The purpose of these experiments is to choose in a simplified way the best yield point for each of the components A', B1' and B2'. For A' and B', clay with different contents of water was tried and for B1' doughs made from wheat flour with different contents of water. A number of combinations were tried.

The coextruded samples were dried with hot air, then sliced up with a razor blade, and magnified photos were taken (there had been added different pigments to the three components).

Chosen as the most suitable was:

A': clay with 26% contents of water, showing yield point 1,6kg cm^{-2} (20°C).

B2': the same as A'.

B1': a dough of 1 weight part flour to 1,5 weight parts water, showing yield point 25g cm^{-2} (20°C).

It was therefore decided to aim at these yield points in each of the examples except in examples 1 and 2 where this is probably not possible.

Example 1

Component A: Marzipan

Component B1: Dark chocolate

Component B2: The same dark chocolate

Lubricant for the rams: sunflower oil.

It was found that the marzipan had yield point 400 g per sq. cm. To achieve the same yield point in the chocolate as wanted in the B2' component, it was found that its temperature should be 29.5°C. To achieve the yield point 25g per sq. cm in the chocolate as wanted in the B1' component, it was found that the temperature should be 31°C.

Temperature for the extrusion apparatus: 35°C. Temperature for the marzipan at the entrance to the extrusion die chosen to be 20°C.

Yield point of the chocolate (A-component) at 20°C, as measured on a sample cut out from a plate of the chocolate, is 56kg cm^{-2}.

<u>Example 2</u>

Components B1' and B2': powdered parmesan cheese. The yield point of the mass at 20°C is measured to be 1.3kg cm^{-2}.

Component A'; a dough adjusted by an admixture of bran to show approximately the same yield point, consisting of: 3 weightpart wheat gluten, 15 parts oat bran, 18 parts water, and small amounts of a baking powder.

Lubricant for the rams: egg white.

Extrusion at 20°C.

Aftertreatment: Heating to about 100°C to melt the cheese and bake the dough, by which it also expands. Yield point of the solidified cheese at 20°C:20kg cm^{-2}.

<u>Example 3</u>

Component A'; honey, viscous fluid at 20°C. The preferable yield point for the extrusion, 1.6kg cm^{-2}, was approximately obtained at -15°C which therefore is the chosen extrusion temperature for this component.

Components B1' and B2': Identical compositions, namely 60 parts by weight egg white powder + 150 parts oat bran + 180 parts water. At -1.5°C it shows approximate yield point 25 g cm^{-2}, this temperature therefore is chosen for B1'. The temperature at which it shows approximate yield point 1,6kg cm^{-2}, is chosen for B2'.

Lubricant for the rams: egg white.

Temperature chosen for the extrusion apparatus: + 1°C.

The extruded product is heated to 80°C to make the egg white form gel.

Yield point of the solidified component B: 6,6 kg cm^{-2}.

<u>Example 4</u>

Component A': 470 parts by weight whole milk yoghurt + 25 parts flour sugar + 2,5 parts sodium salt of carboxymethylcellulose (thickening agent) + 10 parts calcium lactate. The latter is admixed in order to react with pectin in the

B1' and B2' components to make them solidify. The thickening agent is preblended with the sugar in order to facilitate the dissolution process.

This component acquires the approximate yield point 1,6 kg cm^{-2} at -5°C, which therefore is chosen for the extrusion of this component.

Components B1' and B2': the same composition, namely: 40 parts by weight pectin (50% hydrolysed grade) + 20 parts flour sugar (dryblended with the pectin) + 360 parts demineralized water. At -1°C it shows the approximate yield point 25g cm^{-2}, this temperature therefore is chosen for B1'. At -1.3°C it shows approximate yield point 1,6 kg cm^{-2}, this temperature therefore is chosen for B2'.

Lubricant for the rams: cream.

Temperature chosen for the extrusion apparatus: + 1°.

Solidification of B1' and B2' by 2 days storage by which the calcium ions migrate into the A' component and transforms that into a gel. Yield point of the latter 1,2 kg cm^{-2}.

<u>Example 5</u>

A' component: 8 parts by weight butter + 9 parts sesame oil.

At -14°C this acquires approximate yield point 1.6 kg cm^{-2}, and therefore this temperature is chosen for the extrusion of A'.

Components B1' and B2': the same composition, namely 15 parts by weight oat bran + 3 parts wheat gluten + 18 parts water.

At +1°C the yield point is approximately 1kg cm^{-2}, and this temperature is chosen for both B1' and B2'.

Temperature of extrusion apparatus: +1°C.

Lubricant for the rams: sesame oil.

Solidification of B' by storage for a short time at 100°C.

Yield point of the solid B: 1,0 kg cm^{-2}. The solid B is microporous.

Claims

1. A three-dimensional food product, elongated in at least one dimension (the z-dimension) and consisting of at least two components which have been coextruded to become interspersed with each other, in which one or more cells of components A are surrounded at least in the xz plane by one or more components B which form cell walls (2, 4) surrounding the A component characterised in that the or each B component is a solid (including a viscoelastic solid) at 20°C the cells of components A are arranged in at least two mutually distinct rows (3) extending generally in the z direction, each said row of cells being separated from the adjacent row by a generally continuous (in the z-direction) boundary cell wall of B component (2), and either a) A having no compressional yield point (being a fluid) at 20°C or having plastic, pseudoplastic or viscoelastic consistency at 20°C and having a compressional yield point YP_{A20} at 20°C which is less than 0.5 x the compressional yield point of B at 20°C (YP_{B20}) or b) A being an expanded material containing at least 50% by volume gas.

2. A product according to claim 1 in which each cell of A extends in a generally Y direction substantially from a position at or adjacent to one xz face of the food product to a position at or adjacent the other xz face.

3. A product according to claim 1 in which the boundary cell wall (2) is formed of a component B1 and the product has bridging cell walls (4) branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall (2), the bridging cell walls (4) being formed at least in part of a B component B2 being different to B1.

4. A product according to claim 1 in which the boundary cell wall (2) is formed of at least two different components B1 and B2 and the product has bridging cell walls (4) branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall (2), the bridging cell walls (4) being formed at least in part of B2.

5. A product according to claim 3 or claim 4 in which the components B1 and B2 have different yield points at 20°C, preferably in which the yield point of B1, $YP_{B1(20)}$, is in the range 0.1 to 0.5 of the yield point of B2, $YP_{B2(20)}$.

6. A product according to claim 1 in which each of the cells of A extend part way between the two xz faces, and in which two or more cells span the distance between the two xz faces and are separated from one another in the y-direction and in which there are B components arranged between adjacent cells of A which are separated from one another generally in the y direction and forming cell walls (5) around each A cell, so that the A cells are substantially enveloped by cell walls of B.

7. A product according to claim 4 and claim 6 in which the B components (5) between adjacent cells of A separated in the y-direction comprises B1.

8. A product according to claim 1 in which the B component is formed of a single component and in which there are bridging cell walls (4,5) branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall and around each cell of A.

9. A product according to claim 1, characterised in that if the bridging cell walls that is walls other than the boundary cell wall are attenuated in the vicinity of the boundary cell wall the local thickness the attenuated wall (6) is generally not any thinner than 1/15 of the thickest portion (8) of said wall.

10. A product according to claim 8, characterised in that the said boundary cell walls of B-component extend in waved or zig-zagging manner about a plane extending in the zy plane.

11. A product according to any of claims 5 to 10 in which the bridging cell walls (4) which branch off from the boundary cell walls (2), considered in a yz plane, branch off substantially perpendicularly to the boundary cell wall at the branching point.

12. A product according to any preceding claim which further comprises edge boundary cell walls of B extending substantially continuously generally in the z- direction along or adjacent to each yz face of the product.

13. A product according to claim 1 in which each boundary cell wall (2) is substantially planar, lying generally in a yz plane.

14. A product according to any preceding claim in which the cross section of cells of A in the xz plane has an average dimension in the z direction in the range 0.5 to 10 mm, preferably in the range 1-5 mm.

15. A product according to any preceding claim in which the average cross-sectional area of cells of A in the xz plane is in the range 0.5-100mm^2, preferably 1-25mm^2.

16. A product according to any preceding claim in which the average row separation is in the range 1-25mm, preferably 3-15mm.

17. A product according to claim 16 in which the boundary cell walls (2) have a minimum thickness in the x direction in the range 5-50% of the average row separation, preferably at least 10%.

18. A product according to any preceding claim in which the bridging cell walls (4,15) (being cell walls between cells of A other than boundary cell walls) have a minimum thickness of 0.1 mm, preferably a minimum thickness of 0.5 mm.

19. A product according to any preceding claim, characterised in that A in the final form of the product at 20°C is fluid.

20. A product according to any of claims 1 to 18, characterised in that A in the final form of the product at 20°C is a plastic pseudoplastic or viscoelastic material cell having a compressional yield point, YP_A lower than 1000 g cm^{-2} and preferably lower than 500 g cm^{-2}.

21. A product according to claim 20, characterised in that A consists of a blend of on one hand short fibres, nut-, grain- or shell-pieces, film-pieces or flakes and on the other hand a water based solution or gel.

22. A product according to claim 20, characterised in that A consist of a blend of on one hand short fibres, nut-, grain, or shell-pieces, film-pieces or flakes, and on the other hand an oil.

23. A product according to any preceding claim, characterised in that B is a gel.

24. A product according to any preceding claim in which B, optionally reinforced with short fibres, or grain-, shell- or film-pieces or flakes, has a yield

point, YP_B, of at least 200 g cm^{-2}, preferably in the range 500 to 80,000 g cm^{-2}, and more preferably no more than 60,000 g cm^{-2}.

25. A product according to any preceding claim, characterised in that B is based on fat , oil or wax with additions for the taste, preferably it consists of chocolate.

26. A product according to any of claims 1 to 24, characterised in that B is based on protein.

27. A product according to any of claims 1 to 24, characterised in that B is a microporous agglomerate of particles containing water in the pores, and that the said particles consist of short fibres or grain-, shell- or film-pieces or flakes, which particles are bonded together by polymeric micro-strands, e.g. consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

28. A product according to any of claims 1 to 24, characterised in that B is or contains a gel based on a polymer belonging to the group of carbohydrates or carbohydrate related compounds.

29. A product according to claim 1, characterised in that B comprises a polymer and the boundary cell walls of B extending in a generally z direction are molecularly oriented in the general z direction.

30. A product according to claim 1, characterised in that A is a juice optionally in form of a soft gel or with a thickening agent and being flowable, and that A contains dissolved sugar.

31. A product according to claim 1, characterised in that A is a juice optionally in form of a soft gel or with a thickening agent, and that A contains hydrolysed proteins to give it taste and nutritional value comparable to meat.

32. A product according to claim 1, characterised in that A contains a pulp of short protein fibres or pieces of protein film.

33. A product according to claim 1, characterised in that A is a cultured milk product.

34. A product according to claim 1, characterised in that A is marzipan.

35. A product according to claim 1, characterised in that A is a paste based on meat.

36. A product according to claim 1, characterised in that the A component contains gas.

37. A bread or cake product according to claim 36, characterised in that A is based on expanded and baked starch and B is based on protein.

38. A product according to claim 36 characterised in that B comprises cheese.

39. A product according to claim 1, characterised by containing two different A-components, A1 and A2.

40. A product according to claim 39 in which A1 is a waterbased solution or gel or contains such solution or gel as matrix for solid particles, and A2 is fat- or oil-based or contains fat or oil as matrix for solid particles.

41. A three dimensional solid (including viscoelastic solid) food product elongated in at least one dimension (the z-dimension) and consisting of at least two components having different visual appearance which have been coextruded to become interspersed with one another in which there are segments of A and segments of B, characterised in that the or each B component is a solid (including a viscoelastic solid) at 20°C the or each A component is a solid (including a viscoelastic solid 20°C), the segments of A are arranged in at least two mutually distinct rows extending generally in the z-direction, and in which the rows of A and interspersed B are visible at at least one surface of the product extending in a general xz plane.

42. A product according to claim 41 in which the thickness of the segments of A and the segments of B are attenuated (6) close to the border between two rows as compared to their thickness at points (8) distant from the boundary cell walls (where the thickness at any point is the shortest distance across the segment at that point) and in which the segments are dragged out so as to form an acute angle of less than about 45° with the z-direction in the xz plane.

43. A product according to claim 41 or 42 in which A and B consist of one of the following combinations:

a) darker chocolate/ligther chocolate

b) chocolate/marzipan

c) chocolate/caramel

d) two differently coloured gums or fruit gels.

44. A method of manufacturing by coextrusion in an extrusion die a food product in which the components are extruded in a z-direction from the extrusion die, and in which at least one extrudable component A' is formed into a flow through a channel and an extrudable component B' is formed into a flow through a channel, the flow of B' being x-wise adjacent to the flow of A', x being transverse to z, in which the flows of A' and B' exit from the channels through exits after which, the flows of A' and B' are regularly divided in a generally x-direction by a dividing member (10) to form at least two rows of flows of A' and B' separated in the x-direction, in each of which rows the flows of A' and B' are segmented in the z direction and in which in each said row a segment of flow of B' is joined upstream and downstream to each segment of flow of A' whereby B' segments are interposed between adjacent A' segments in the z direction and in which adjacent rows are joined to one another along their yz faces, each row of segmented flows of A' forming a row of cells of A' extending generally in the z direction and wherein after the joining of the segmental flows B' is transformed to a solid material (including a viscoelastic solid) B, or, if B' is already viscoelastic, is transformed to a material B having a compressional yield point which is at least twice that of B'.

45. A method according to claim 44 in which after the said joining the material A' is expanded to at least twice the volume of A', or, if A' is plastic, pseudoplastic or viscoelastic is transformed to a material A having a lower yield point than the yield point of A' by a factor of at least 2 or to a fluid, or, where A' is a fluid, is transformed to a fluid A having an apparent viscosity less than half that of A'.

46. A method according to claim 44 or claim 45, <u>characterised in that</u> the extrusion is carried out at an elevated temperature and the transformation of B' takes place by cooling.

47. A method according to claim 44 or claim 45, characterised in that the said transformation of B' takes place by coagulation or gel formation.

48. A method according to claim 47, characterised in that the coagulation or gel formation is established by heating.

49. A method according to claim 47, characterised in that prior to the coextrusion process B' is formed as an extrudable material by disruption of a continuous, firm gel structure, and after the end of the coextrusion the continuous firm structure of this gel is reestablished by heating followed by cooling, or, if the gel is adequately thixotropic, spontaneously or upon storage.

50. A method according to claim 47, characterised in that the coagulation or gel formation is carried out by chemical reaction.

51. A method according to claim 50, characterised in that when the gel formation can be made sufficiently slow, the gelling reagent or coagulant is incorporated into B' prior to the coextrusion process.

52. A method according to claim 51 in which the reagent or coagulant is incorporated into solid particles suspended in B'.

53. A method according to claim 51 in which the gel formation or coagulation is enzymatic, for instance involving a protease such as rennin to break down and coagulate milk protein.

54. A method according to claim 47, characterised in that the gel formation or coagulation is established by including a reactant in the A', this reactant gradually migrating into B' component when the components are brought together in the coextrusion die.

55. A method according to claim 54, characterised in that the transformation partly occurs by precipitation in the B' of an inorganic salt, e.g. calcium phosphate, formed by reaction between ions in A' and ions in B'.

56. A process according to claim 51, characterised in that by a chemical reaction preformed solid particles are coagulated to continuous firm material.

57. A method according to claim 44 or claim 45, characterised in that during the extrusion B is mainly in the form of a firm material in particle form suspended in water, and after the end of the extrusion at least a part of the

particles are first fused and then transformed by cooling to make the material cohesive.

58. A method according to claim 44 or claim 45, <u>characterised in that</u> in order to operate the extrusion process with A' in suitable extrudable state but achieve a more flowable consistency or lower yield point of A in the final product, A' is cooled prior to the extrusion sufficiently partly to solidify (including precipitate) a major portion at least of the material in A' as particulate suspended solids and after the extrusion the particulate solids are melted or redissolved.

59. A method according to claim 44 or claim 45, <u>characterised in that</u> in order to operate the extrusion process with A' in suitable extrudable form but achieve a more flowable consistency of A in the final product, A' is applied to the extrusion process in said state by including in A' a polymer in dissolved or suspended particulate form, which is depolymerised at least in part after finalisation of the extrusion process.

60. A method according to claim 59, <u>characterised in that</u> the depolymerisation process is enzymatic.

61. A method according to any of claims 44 to 60 which A' is formed into at least two flows separated from one another in the x direction and in which B' is formed into at least two flows separated from one another in the x direction and in which flows of B' are interposed between part of adjacent flows of A'.

62. A method of coextruding two materials A' and B' in an extrusion die in which at least one extrudable component A' is supplied from a reservoir for A' and is formed into a flow through an extrusion channel to an exit for A' from the channel, and at least one extrudable material B' is supplied from a reservoir for B' and is formed into a narrow flow through an extrusion channel to the exit for B' from the channel in which the flows of A' and B' are each divided at or after the respective channel exits to form segments of respective extrudates each by a dividing member (10) which moves relative to the channel exit from a first position to a second position in which the dividing member has traversed the entire channel exit, and the flows of both A' and B' out of the

extrusion channels are intermittent in nature, controlled either by providing a ram (35, 53, 54, 55) close to or within each channel which drives the flow intermittently or by opening a valve (46, 48) between the inlet to the respective extrusion channel and the reservoir from which the component is supplied under pressure, the movement of the ram or the opening of the valve, as the case may be, being co-ordinated with the relative movement (11) between the dividing members and the channel exits such that material is driven through the exits while the relative movement is stopped in said first and second positions, but is not driven through the exits during the change of positions.

63. A method according to claim 62 in which each ram (35, 53, 54, 55) is operated in a series consisting of more than one inward step, preferably at least 5 inward steps, for instance up to 20 inward steps, and in which after a series of inward steps the ram is retracted.

64. A method according to claim 62 or claim 63 and in which A' is fed from the respective reservoir into a feeding slot which feeds into each of the channels for A', and B' is fed from the respective reservoir into a feeding slot (27, 28, 29) which feeds into each of the channels for B' and in which a single ram (35) is driven to the feeding slot to drive material through the slot and in which the ram is driven into the feeding slot preferably in a series of more than one inward step; preferably at least 5 inward steps, for instance up to 20 inward steps, and in which, after a series of inward steps the ram is retracted and the feeding slot filled with extrudable material from the respective reservoir.

65. A method according to any of claims 62 to 64 in which there is a segment of flow of B' joined both downstream and upstream to each segment of flow A'.

66. A method according to claim 65 in which at least two x-wise adjacent z-wise extending rows of segments of A' and segments of B' are joined to one another along their generally zy faces.

67. A method according to claim 44 or 66 in which the rows are joined in a collection chamber and in which the sheet that is formed is preferably taken off on a conveyor (22).

68. A method according to claim 44 or claim 65 in which, after the channel exit B' is modelled around A' segments so as to surround the A' segments substantially completely in an xz plane.

69. A method according to claim 68, characterised in that the said modelling is effected by selecting a B' which under the process conditions is a fluid or has a compressional yield point which is significantly lower, preferably by a factor of at least 2, than that of A', and if this provision is not sufficient to avoid sticking of the A-component to the dividing members, further adding a food acceptable release agent such as e.g. cream to the A-component.

70. A method according to claim 65 or 68 , characterised in that in order to establish or facilitate the modelling of component B' around the segments of component A' flows of component B' are merged with each flow of A' before this reaches the channel exit, this merging being on both sides (in the x direction) of A' to form a composite flow of B'A'B' configuration.

71. A method according to claim 70 in which there are several x-wise separated composite flows B'A'B' and the exits through which such composite B'A'B' streams are extruded alternate (generally along the x-direction) with exits through which plain B component is extruded, whereby immediately after the dividing the segmental streams will consist a transverse row of B'A'B' segments alternating with B' segments.

72. A method according to claim 69, in which there are two B' components B1' and B2' to become modelled together around each segment of A', and in which B1' is merged with A' to form composite flows B1'-A'-B1' as defined in claim 73, characterised in that B1' in a similar manner is merged with B2' to form composite flow B1'-B2'-B1', and the orifices for the composite B1'-A'-B1' flows alternate (in a generally x-direction) with the exits for the composite B1'-B2'-B1' flows whereby immediately after the dividing the segmental streams will consist of a transverse row B1'-A'-B1' segments alternating with B1'-B2'-B1' segments.

73. A method according to claim 70, characterised in that the said merging is carried out in such a way that there is also formed a B'A'B' configuration when the composite stream is viewed in xy section through A, or

optionally a configuration with a longer sequence of alternating B' and A' segments, B' being at the beginning and end of this sequence.

74. A method according to any of claims 44 to 73 in which each dividing member (10) reciprocates relative to the or each said exit.

75. A method according to claim 74 in which the dividing members move in a plane, or on a circular cylindrical surface.

76. A method according to claim 75 in which x is substantially vertical and y is substantially horizontal and in which the reciprocation is in a substantially vertical plane (xy plane) or is about a horizontal axis.

77. A method according to any of claims 44 to 76, characterised in that the dividing members (10) are installed in fixed dieparts, while the assembly of channels and orifices moves.

78. A method according to any of claims 44 to 76, characterised in that the orifices are installed in a fixed diepart, while the dividing members (10) are installed in a reciprocating or rotating diepart.

79. A method according to any of claims 44 to 78, characterised in that each orifice is arranged in close proximity to or directly contacting the or each dividing members (10), whereby the dividing takes place by the shear between the exit walls (9) and the dividing member (10).

80. A method according to claim 79, characterised in that the dividing of each flow to segments is performed by a cutting action.

81. A method according to claim 80, characterised in that the cutting is performed by forming the upstream end of the or each dividing member generally as a knife at least on one x-directed side of the dividing member, the edge of the knife pointing generally in a direction parallel to the direction of said shear.

82. A method according to claim 80 or 81, characterised in that th cutting is performed by forming the or each of the orifices walls (9) generally as a knife at least on one x-directed side, the edge of the knife pointing generally in a direction parallel to the said direction of said shear.

83. A method according to claim 83 or 84, in which to enhance the effect of cutting, the or each orifice and/or the or each dividing member (10)

performs relatively fast and relatively small vibrations relative to each other generally in the y-direction these vibrations being in addition to the slower and bigger reciprocations along the direction (11) defined by the line of orifices, whereby the knives perform a sawing action.

84. A method according to claim 62 in which the pressure in each reservoir is controlled in coordination with the movement of the rams (35, 53, 54, 55) whereby extrudable material is driven from the reservoir as the ram is retracted but is not driven from reservoir as the ram is driving material through the channel.

85. A method according to claim 84 in which there is a non-return valve (43) between each reservoir and the respective channel preventing return of material in the channel-reservoir direction.

86. A method according to claim 85 in which the non-return valve is at the inlet into each channel.

87. A method according to claim 44 or 62, characterised in that the division between the channels for A' and the division between the dividing members (10) are adjusted to each other and at least component A' is extruded in a rhythm syncronized with the relative reciprocation or rotation (11) between the orifices and dividing members in a manner to produce maximum driving force on the component while each of the orifices for the component is aligned with a space channel formed between a pair of dividing members.

88. A method according to claim 80 in which the assembly of channels and orifices is pressed against the fixed assembly which comprises the feeding slots (27, 28, 29) during refilling of the channel with extrudable material and pressure is released at least in part while the movement (11) of the movable assembly takes place.

89. A method according to claim 62 in which the dividing members are pressed against the extruder parts (44) in which the exits are formed while material is driven through the exits, and are not pressed together during said relative movement.

90. A method according to claim 44 or 62, characterised in that in the dividing process a layer of B' is formed on each generally xz face of the product

by making the or each orifices from which B' flows extend beyond in the y direction the internal orifices from which A' flows whereby B' extruded through the orifice will be sheared out to form said layers.

91. A method according to any of claims 44 to 90, characterised in that in the dividing process there is also interposed one or more layers of B' between adjacent segments of A' separated from one another in the y-direction by making each internal orifice for A' interrupted at one or more locations along the y axis without making the orifices for B' interrupted, whereby the shear will establish the interposing and formation of the layer or layers of B' extending in a generally xz plane.

92. A method according to claim 91 in which the or each orifice for A' are provided with ribs (14) extending across the exit in a generally x direction to create the said interruptions, and in which B' is sheared over the surface of A' segments by provision of shear plates (17) each of which is aligned to be in the same generally xz plane as the respective ribs.

93. A method according to claim 72, characterised in that B2 is formed into a gel at least in part while it proceeds as flows towards the dividing process.

94. A method according to claim 62, characterised in that a lubricant capable of forming a harmless part of the product is injected around the or each said ram (35, 53, 54, 55) in amounts sufficient to follow the extrudable component acted on by the ram device, thereby also lubricating the walls of each channel through which the component is extruded to significantly reduce the backpressure created by the extrusion through the channel.

95. A method according to claim 70 in which the merging of A' and B' flows takes place in an internal die comprising a central channel through which A' flows and a peripheral channels on each x-wise side of the central channel through each of which B' flows the central channel having valve means (13) allowing closing of the central channel to minimise flow of B' into the central channel.

96. A method according to claim 95 in which the value means (13) are actuable by controlling the pressure in the flows of A' and B' and preferably

comprise springy blades extending along each side of the central channel joined thereto by fluid tight, joins along one long blade edge, the blades being of suitable size and springiness that they meet at their opposite long edges to close the channel.

97. A method of manufacturing by coextruision of a food product in sheet, ribbon or filament form, which product consisting of at least two components A and B, segments of B being in contact with segments of A, in which flows of A' and B' are coextruded from orifices of an extrusion die and, after extrusion, B' is transformed to a solid material (including a viscoelastic solid) B, or, if B' is already viscoelastic, is transformed to a material B having a compressional yield point which is at least twice that of B', in which B' is transformed by coagulation or gel formation initiated by a coagulant or gelling reagent incorporated in A'.

98. A method according to claim 97 in which the coagulant or gelling reagent is an enzyme, preferably a protease, for instance rennin.

99. A method according to claim 98 in which B' comprises a protein, for instance milk protein.

100. Apparatus suitable for carrying out a process according to claim 44, comprising an extrusion die having channels for flow of two different extrudable materials and orifices for exit in a generally z direction of material from the channels which are separated from one another in the x direction, further comprising dividing members (10) capable of producing at least two rows of flows of extrudate by moving across the orifices to divide the flows in a generally x direction, and comprising further means for subjecting the product to conditions to transform components of the product form a relatively soft material to a relatively hard material.

101. Apparatus suitable for carrying out a process according to claim 62, comprising an extrusion die having channels through which at least two different materials may flow, means for driving the material through the channels and out of the orifices which are separated from one another in the generally x direction, and having dividing members (10) which are capable of moving across the orifices to divide the flows of extrudate therethrough in a

generally x direction, in which the movement of the dividing members and the driving of the material through the channels are controlled so that material is diriven through the orifices while relative movement between the dividing members and the orifices is stopped.

102. Apparatus according to claim 100 or 101, further having features as described herein.

103. Apparatus as described herein and substantially as illustrated in the drawings.